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Government subsidies and corporate investment efficiency: Evidence from China

Jinshuai Hu[a], Haiyan Jiang[c], Mark Holmes[b,*]

[a] Institute for Financial and Accounting Studies, Xiamen University, Xiamen 361005, PR China
[b] School of Accounting, Economics and Finance, Waikato Management School, University of Waikato, Private Bag 3105, New Zealand
[c] Department of Accounting and Corporate Governance, Macquarie Business School, Macquarie University, NSW 2109, Australia

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ABSTRACT

This study examines how state subsidies to firms affect corporate investment efficiency. Using archival data from a sample of Chinese listed firms over the 2007–2015 period, we find that government subsidies have a negative effect on firms' investment efficiency, and this negative effect is more pronounced for firms that are less financially constrained. Further analyses suggest that government subsidies are positively associated with firms' over-investment, although they alleviate under-investment. Our findings are robust to a series of tests to alleviate concerns about potential endogeneity and self-selection bias.

1. Introduction

Governments subsidise business sectors to promote economic growth, offset market imperfections, develop economies of scale and meet social policy objectives (e.g. Schwartz and Clements, 1999). At country or industry levels, government subsidies can affect operational efficiency (Dube, 2003; Kebede, 2006), production capacity (Cotti and Skidmore, 2010), research and development activities (Gorg and Strobl, 2006; Liu and Shieh, 2005), employment (Girma et al., 2008) and export competitiveness (Desai and Hines, 2008). At the firm level, government subsidies have been found to influence firm value (Bar-Yosef and Landskroner, 1988; Lee et al., 2014), firm performance (Balsari and Ucdogruk, 2008), firm productivity (BergstrÖm, 2000; Harris and Trainor, 2005) and voluntary social and responsibility disclosures (Lee et al., 2017). Our study adds to this literature by investigating the effect of government subsidies on corporate investment efficiency. In doing so, we explore the effect of subsidies on corporate over- and under-investment, and the moderating effect of the recipients' financial constraints.

Government subsidies are widespread in China and have the primary goal of promoting the development of strategic industrial sectors such as agriculture, public utilities and high-tech industries (Chen et al., 2008). The government also provides subsidies to firms to alleviate capital constraints and support firms in financial difficulties (Claro, 2006; Lee et al., 2014). The amount of the subsidies is often at the discretion of local governments and varies significantly between subsidised firms (Lee et al., 2014). As subsidies are highly discretionary, and there is a lack of systematic reporting and monitoring of the utility of subsidies in China (Zhang et al., 2014), little is known about the effect of subsidies on corporate investment efficiency. Chinese local governments provide subsidies to help firms boost their earnings for rights issues and avoid delisting (Chen et al., 2008).[1] He (2016) finds that

* Corresponding author.
E-mail addresses: hujs@xmu.edu.cn (J. Hu), haiyan.jiang@mq.edu.au (H. Jiang), mark.holmes@waikato.ac.nz (M. Holmes).

[1] The China Securities and Regulatory Commission (CSRC) uses bright-line regulatory benchmarks to grant approvals for IPOs and rights offerings and to initiate performance-related delisting. Chinese listed firms have an incentive to manage reported earnings to meet these specific performance benchmarks (Piotroski & Wong, 2012).

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subsides help firms achieve their desired earnings targets for IPO purposes. Both of these studies find opportunistic use of government subsidies by Chinese listed firms, and thereby cast doubt on the efficiency of subsidies. These results are the motivation for our research. Our inquiry is also motivated by the scarcity of research on government subsidies at the firm level, although there are many studies of their macro-economic effects at the country and industry levels (e.g. Schwartz and Clements, 1999; Stiglitz, 1993; (Bagwell and Staiger, 1989; Claro, 2006; Lopez and Galinato, 2007; Neary, 1994).

Using archival data of listed companies in China from 2007 to 2015, we conduct a batch of analyses of corporate investment efficiency. After controlling for determinants of investment efficiency identified in previous studies, we find that in general, subsidies adversely affect corporate investment efficiency. Furthermore, we define investment inefficiency in terms of over- and under-investment, and then test the effects of subsidies on over- versus under-investment. The results suggest that subsidies exacerbate over-investment but alleviate under-investment, suggesting that subsidies create a tendency to waste financial resources on unprofitable projects – a manifestation of over-investment. This finding is in accordance with the evidence for over-investment by Chinese state-owned enterprises (SOEs) due to their soft budgets and inadequate supervision (e.g. Bai & Lian, 2013). SOEs also have significant advantages in receiving government subsidies thanks to their ownership ties with the government (Bajona & Chu, 2010; Eckaus, 2006). In addition, the results support our proposition that the inefficient use of subsidies is more severe in firms with abundant financial resources than in firms where financial resources are constrained, indicating that subsidies granted to financially sufficient firms can induce inefficiency. These results hold after we conduct a set of robustness analyses to alleviate concerns about endogeneity and self-selection bias. Collectively, our research sheds light on how government financial aid influences firms' investment efficiency in China, where government intervention in the economy and business is pervasive.

Our study makes a number of key contributions to the literature. First, to the best of our knowledge, this study is the first to examine the effect of government subsidies on investment efficiency at the firm level. Although government subsidies have been found to have a substantial macro-economic impact on country and industry level operational efficiency, production capacity, and firm value and profitability, the mechanisms through which the effects take place are largely unexplored. Our study distinguishes itself from previous studies by delving into the effect of subsidies on corporate investment efficiency and thus providing micro-economic evidence for the effect of government subsidies on corporate investment inefficiency. Therefore, the results provide a potential explanation for subsidies' effect on firm-, industry- and country-level economic performance.

Second, previous studies of the effects of government subsidies are inconclusive (Bagwell and Staiger, 1989; Claro, 2006). Some studies have found that government subsidies can be value-enhancing, whereas others suggest that they foster inefficiency. Our study identifies a potential moral hazard for subsidy recipients: subsidies can encourage over-investment resulting in investment inefficiency, and this effect is more pronounced for firms that are less financially constrained. Hence, our findings have practical implications for governments in terms of the need to prioritise subsidy recipients based on their financial conditions and to monitor the utility of subsidies. Third, our sample of Chinese data offers a rich insight into the Chinese context. The use of subsidies is widespread and crucial to business success in China. Compared with their counterparts in the US, many Chinese firms have received government subsidies.[2] With a large sample of firms taken from an archival dataset, we provide credible evidence that is informative for other countries, because subsidies are common economic transactions practised by governments in most countries.[3]

The remainder of the paper is organised as follows. Section 2 reviews the relevant literature and develops testable hypotheses. Section 3 describes the research design, followed by Section 4 which presents the main test results and robustness analyses. Section 5 concludes the paper.

2. Literature review and the development of hypotheses

2.1. Literature review and institutional background

Government subsidies shape domestic resource allocation decisions, income distribution, expenditure productivity, structural and sectoral adjustment, and international resource allocation affected by subsidy recipients' international competitiveness (Schwartz and Clements, 1999). Whether government subsidies are a necessary mechanism for economic adjustment and whether they are beneficial or detrimental to a free-market economy are contentious issues.

Proponents of government subsidies argue that government subsidies are applied around the world to overcome market imperfections, exploit economies of scale and promote social policies (e.g. (Schwartz and Clements, 1999; Stiglitz, 1993). Opponents argue that subsidies are often ineffective (i.e. they fail to benefit the recipients) and costly (i.e. they have adverse real welfare and distributional implications). They further argue that subsidies result in an inefficient allocation of resources and deadweight losses if they are imposed on a competitive market: ‘Subsidies lead to overproduction of the subsidised good, since production and consumption are expanded beyond the point where the marginal social benefit of consuming the good are equal to or greater than the marginal social costs of production’ (Schwartz and Clements, 1999, pp. 129–130). Empirical research provides mixed results regarding the consequences of state subsidies around the world. Some studies suggest that such subsidies are beneficial (Bagwell and

[2] For instance, our sample shows that 70% of Chinese listed firms in 2013 received government subsidies. This is much higher than the 10% in the study by Pappas et al. (2017) using US data. Specifically, Pappas et al. (2017) start the sample with 59,285 firm-year observations, and show that only about 10% of the initial sample, 5878 firm-year observations, received subsidies.

[3] Government subsidies are so common that there is a specific International Accounting Standard, IAS 20 *Accounting for Government Grants and Disclosure of Government Assistance*, dedicated to reporting subsidies.

Staiger, 1989; Claro, 2006), whereas others infer that they are detrimental due to the resulting overproduction or efficiency losses at the macro-economic level (Lopez and Galinato, 2007; Neary, 1994).

In developed economies like the US, subsidies through non-tax channels, such as direct tax injections, loan guarantees and debt forgiveness, are based on competitive applications (Alesina and Ardagna, 2010). In contrast, in the Chinese political economy, subsidies are also driven significantly by political influence (Haley and Haley, 2013) and are largely determined at the discretion of officials based on the political connectedness of firms (Chen et al., 2008; Du and Mickiewicz, 2016). During China's economic liberalisation process, the political system has become highly decentralised, giving local governments autonomy within their jurisdictions (You and Du, 2012). This decentralisation has generated strong inter-jurisdictional competition incentives between local governments (Xu, 2011). To increase regional GDP, local governments have strong incentives to support local firms. Granting subsidies to improve local listed firms' reported earnings, cash flow and competitiveness is one of the strategies commonly used by local governments (Chen et al., 2008).

Government subsidies are scarce resources not available to all listed firms. Local governments have discretion over the size and recipients of subsidies, setting and changing eligibility criteria based on their objectives (Aschhoff, 2008). In China, government subsidies often include treasury direct subsidies, value-added tax (VAT) refunds, corporate income tax refunds, technology and innovation grants, etc. Direct subsidies, such as cash payments and loan guarantees, are the focus of this study, because they are non-tax-based subsidies allocated in a relatively discretionary manner by local governments (Lee et al., 2014).[4]

A few Chinese studies provide valuable insights into the firm-level determinants of receiving subsidies and the consequences of subsidies. To investigate the determinants of subsidies, Lee et al. (2014) interview government officials, accountants, entrepreneurs, academics and analysts. Their interview-based evidence suggests that one important determinant is the existence of personal connections (or guanxi) between entrepreneurs and officials. Wu and Cheng (2011) argue that managers with political connections may influence the government subsidies decision-making process by lobbying policymakers. In addition, managers with prior political experience are familiar with government procedures and preferences and are thus able to predict government resource allocation priorities. This insight, in turn, provides the connected firms with greater opportunities to receive government funding than their counterparts without political connections. A recent paper by Jiang et al. (2018) reports that Chinese firms tend to manipulate earnings downwards to compete for government subsidies; however, the market discounts the ‘good news’ of subsidies received by firms that have conducted such downward earnings management.

In terms of consequences, studies show that local governments may opportunistically give subsidies to help firms boost their earnings for rights issues and to avoid delisting[5] (Chen et al., 2008). As political connections are often used to secure government subsidies (Johnson and Mitton, 2003; Lee et al., 2014), Wu and Cheng (2011) argue that due to the role of political favours, subsidies may generate incentives for firms to take actions that are not economically desirable for the firms. In addition, although studies reveal that government subsidies are relevant to market value (Lee et al., 2014; Jiang et al., 2018), the market appears to understand firms' opportunism in pursuing subsidies and thus ‘punishes’ firms receiving subsidies through inappropriate means by discounting their share prices (Jiang et al., 2018). In addition, a recent study reports that subsidies granted by the Chinese government to firms are negatively related to firm performance (Bu et al., 2017). We take a different approach to the consequences of subsidies, focusing on investment efficiency as a mechanism through which government subsidies affect firms' economic performance.

Investment efficiency allows firms to increase shareholders' wealth over the long run, because investment in profitable projects results in positive returns that support the firms' long-term growth. In the neoclassical framework, the marginal Q ratio is the sole driver of capital investment policy (e.g. (Abel, 1983; Hayashi, 1982; Yoshikawa, 1980). Firms invest at the equilibrium point where the marginal benefit of capital investment equals the marginal cost after taking into account the adjustment costs of installing the new capital. Firms obtain financing for positive net present value projects evaluated with the economy-wide interest rate and then return excess cash to investors (Biddle et al., 2009). However, it is recognised that firms may depart from this optimal level and either over- or under-invest, resulting in investment inefficiency. Previous studies have identified two primary drivers of investment inefficiency: moral hazard and adverse selection. Moral hazard arises when managers invest to maximise their personal welfare rather than shareholders' interests (Berle and Means, 1932; Jensen and Meckling, 1976), whereas adverse selection is caused by information asymmetry between managers and outside suppliers of capital, which affects the efficiency of capital investment. When there is divergence in principal-agent incentives, managers will invest in negative net present value projects as a manifestation of moral hazard. Although moral hazard can result in either over- or under-investment based on the availability of capital, the natural tendency to over-invest will produce excess investment if firms have resources to invest. Jensen (1986) also predicts that managers have incentives to grow their firms beyond the optimal size.

[4] A VAT refund is less likely to be manipulated, as it is not subject to local government administration. The aim of the tax-based subsidies is to encourage the development of certain industries, businesses and prioritised regions (Lee et al., 2014; He, 2016). Only firms located in special economic zones, or operating in industries prioritised by the government, are entitled to receive tax-based subsidies. Previous studies (Chen et al., 2008; Lee et al., 2014; He, 2016) suggest that tax refunds (and technology and innovation grants) provide little discretion for local governments.

[5] The CSRC uses bright-line regulatory benchmarks to grant approvals for IPOs and rights offerings and to initiate performance-related delisting. The CSRC has set and changed the standards required for listed firms to issue right shares quite frequently over the years. In 1993, firms were required to have only two consecutive years of profits before they could issue rights. In September 1994, the CSRC specified, for the first time, that a firm must have an average ROE of more than 10% in the previous three years before it could issue rights. In January 1996, the CSRC toughened this requirement, stating that a firm must have more than 10% ROE for each of the previous three years. CSRC then lowered the standard in March 1999, requiring that firms have an average ROE above 10% in the past three years but not lower than 6% in any of these years. In March 2001, CSRC further lowered the standard, stating that firms must have an average ROE above 6% in the past three years. Chinese listed firms have an incentive to manage reported earnings to meet these specific performance benchmarks (Piotroski & Wong, 2012).

2.2. Hypotheses development

Government subsidies help firms to overcome capital constraints (Claro, 2006; Li, 2002). If subsidies are granted to firms with good investment opportunities, the firms will have more capital to pursue investment projects that have positive net present value (NPV). As a result, firms' investment efficiency improves. However, in the case of government officials allocating subsidies to boost or rescue poorly performing firms, and/or subsidy recipients investing in negative net present value projects as a result of managers' moral hazard, subsidies will be used inappropriately, which can result in the misallocation of subsidies to unprofitable projects, leading to investment inefficiency.

Given the opportunism associated with the granting and receiving subsidies, but also the potential benefits associated with using subsidies to increase shareholders' value, it is unclear whether the financial resources supplied by subsidies are invested in profitable projects. Therefore, we provide our first hypothesis in the null form.

H1. *Corporate investment efficiency is significantly associated with government subsidies.*

We are also interested in whether the effect of subsidies on firms' investment efficiency differs between over- and under-investment. It is believed that there is an optimal level of investment in firms that must be maintained to ensure investment efficiency (Biddle, 2009). Therefore, we test the effect of subsidies on both the over- and the under-investment of firms. We posit a differential effect of subsidies on over- and under-investment. Firms with abundant cash flow tend to over-invest (Jensen, 1986; Myers, 1977). When moral hazard occurs among the managers of a subsidy recipient, the investments conducted with the abundant cash flow provided by the subsidy may exceed the optimal level of investment, resulting in over-investment. In contrast, the financial assistance provided through subsidies to firms with limited financial resources makes them less likely to be constrained by cash flow, and thus reduces the probability of under-investment. Taken together, we posit that subsidy recipients will use the injected cash flow to over-spend rather than under-spend, and thus we hypothesise that government subsidies have a positive (negative) relationship with over-investment (under-investment), as stated in Hypothesis 2.

H2. *Government subsidies are positively associated with over-investment, but negatively associated with under-investment.*

We next exploit some cross-sectional variation in the effect of government subsidies on investment inefficiency (over- or under-investment). Specifically, we are interested in the moderating effect of firms' financial constraints. We expect the effect of government subsidies on corporate investment efficiency to be conditional on the recipients' financial constraints. Financial assistance is highly sought after by firms with financial difficulties, because extra cash flow can alleviate their financial constraints. Government subsidies provide firms with an interest free cash flow that is particularly helpful for overcoming temporary credit crunches. Girma et al. (2007) investigate whether Irish government subsidies stimulate productivity growth. They find that government subsidies produce greater increases in productivity in companies with financing constraints. Therefore, we conjecture that although financially constrained firms may be more likely to invest in projects that are value-enhancing, which improves investment efficiency, extra cash injections into firms with sufficient financial resources may encourage wasteful investments, thus reducing investment efficiency. Accordingly, we develop the following hypothesis.

H3. *The effect of government subsidies on investment efficiency is conditional on the financial constraints of the subsidy recipients.*

3. Research design

3.1. Sample and data

The analyses are conducted with a sample of A-share non-financial firms listed on the Shanghai and Shenzhen Stock Exchanges in the 2007 to 2015 period. The data on subsidies are retrieved from WIND, a leading Chinese financial and economics database. We obtain all of the financial and stock market data from the China Stock Market and Accounting Research (CSMAR) database. This sample consists of 12,431 firm-year observations. We begin our sample in 2007 because the new Chinese Accounting Standards (CAS), which converge with the International Financial Reporting Standards (IFRSs), were implemented in this year.

3.2. Model specification

Following previous studies of corporate investment efficiency (e.g. (Beatty et al., 2010; Biddle et al., 2009; Cheng et al., 2013), we test our hypotheses by estimating the following equation using unbalanced panel data:

$$\begin{aligned} Invest_{j,t+1} = {} & \alpha_0 + \alpha_1 Subsidy_{j,t} + \alpha_2 Q_{j,t} + \alpha_3 Q_{j,t} \times Subsidy_{j,t} + \alpha_4 CFO_{j,t} + \alpha_5 Size_{j,t} + \alpha_6 Lev_{j,t} + \alpha_7 Tangile_{j,t} \\ & + \alpha_8 IPOage_{j,t} + \alpha_9 ARET_{j,t} + \alpha_{10} ROE_{j,t} + \alpha_{11} IMR_{j,t} + Industry\ and\ Year\ Fixed\ Effects + \varepsilon_{j,t+1}, \end{aligned} \quad (1)$$

where *Invest* is the sum of capital expenditures including net investment in property, plant, and equipment, intangibles and other long-term assets reported on the Statement of Cash Flow, deflated by lagged total assets. *Q* is Tobin's Q, which is a proxy for growth opportunities. *Q* is measured as the sum of market value and total liability divided by total assets. *Subsidy* is the amount of government subsidies reported under the non-operating income on the Statement of Financial Performance, deflated by total assets. Following Biddle et al. (2009) and Richardson (2006), the model controls for the following variables in year *t* that may affect the level

Table 1
Descriptive statistics and correlation matrix.

Panel A: Descriptive statistics.

Variables	Definition	N	Mean	Standard deviation	25th Quartile	Median	75th Quartile
Invest	Investment, measured as the sum of capital expenditures including net investment in PPE, Intangibles and other long-term assets reported on the Statement of Cash Flow, deflated by lagged total assets	12,431	0.055	0.049	0.018	0.041	0.077
Q	Tobins Q, measured as the sum of market value and total liability divided by total assets	12,431	2.261	1.306	1.370	1.857	2.683
Subsidy	The amount of subsidy deflated by total assets	12,431	0.004	0.005	0.001	0.002	0.006
CFO	cash flow from operating activities deflated by total assets	12,431	0.051	0.077	0.006	0.049	0.098
Size	Firm size, measured as the natural logarithm of total assets	12,431	21.810	1.171	20.960	21.661	22.473
Lev	Leverage, measured as the total liability deflated by total assets	12,431	0.457	0.196	0.305	0.465	0.612
Tangibl	Tangible assets, measured as fixed assets deflated by total assets	12,431	0.254	0.163	0.126	0.224	0.360
IPOage	Number of years since public listing	12,431	9.534	5.584	4.205	9.545	14.090
ARET	Abnormal returns in year t-1	12,431	0.039	0.421	−0.207	−0.024	0.215
ROE	Return on equity	12,431	0.079	0.088	0.032	0.074	0.125

Panel B: Correlation Matrix.

	Invest	Q	Subsidy	CFO	Size	LEV	Tangibl	IPOage	ARET	ROE
Invest	1									
Q	**0.047**	1								
Subsidy	**0.084**	**0.136**	1							
CFO	**0.239**	**0.118**	0.004	1						
Size	**0.023**	**−0.442**	**−0.122**	**0.060**	1					
LEV	**−0.081**	**−0.369**	**−0.144**	**−0.108**	**0.449**	1				
Tangibl	**0.262**	**−0.122**	−0.015	**0.266**	**0.075**	**0.101**	1			
IPOage	**−0.214**	**−0.120**	**−0.130**	**−0.026**	**0.255**	**0.333**	**0.030**	1		
ARET	*0.022*	**0.283**	*0.017*	**0.067**	**−0.024**	**0.026**	**−0.050**	0.004	1	
ROE	**0.136**	**0.176**	**0.030**	**0.315**	**0.204**	**−0.060**	**−0.129**	**−0.039**	**0.150**	1

Note: Bold-faced and italicized correlations are significant at $p < 0.001$ and $p < 0.05$. Variable definitions are in Panel A of Table 1. Continuous variables are winsorized at their 1st and 99th percentiles.

of investment in the following year: *CFO*, *Size*, *Lev*, *Tangibl*, *IPOage*, *ARET* and *ROE*. Industry and year fixed effects dummies are included. Standard errors are clustered by firms to control for potential heteroskedasticity and autocorrelation and to provide robust standard error estimations with reliable t-statistics (Gow et al., 2010; Petersen, 2009).

To further examine the differential effect of subsidies on over- and under-investment, as stated in Hypothesis 2, we first estimate the optimal level of investment and then define over- and under-investment. Based on the theory that investment increases with operating income (e.g.Biddle et al., 2009; Modigliani and Miller, 1958), we first estimate the optimal level of investment using the model defined in Eq. (2), which is drawn from Chen et al. (2011):

$$Invest_{j,t+1} = \gamma_0 + \gamma_1 Neg_{j,t} + \gamma_2 RevGrowth_{j,t} + \gamma_3 Neg_{j,t} \times RevGrowth_{j,t} + Industry\ and\ Year\ Fixed\ Effects + \varepsilon_{j,t+1}, \quad (2)$$

where *NEG* is 1 if last year's operating income growth rate is negative, and 0 otherwise. *RevGrowth* is the percentage change in sales from year *t-1* to year *t*. Eq. (2) is estimated for each industry-year, and the parameters estimated are used to calculate the residual for each firm-year observation. We further define two variables for over-investment (*Over_Invest*) and under-investment *(Under_Invest*). *Over_Invest* takes the value of the residual if it is positive, and 0 otherwise. In contrast, *Under_Invest* takes the value of the residual if the residual is negative, and 0 otherwise. Then, we test Hypothesis 2 using Eq. (3), where *Over_Invest* or *Under_Invest* are regressed on subsidy and a set of control variables, respectively. If H2 is supported, we expect to observe a positive (negative) α_1 when *Over_Invest* (*Under_Invest*) is the dependent variable.

$$Over_{Invest\ j,t+1}/Under_{Invest\ j,t+1} = \alpha_0 + \alpha_1 Subsidy_{j,t} + \alpha_2 Q_{j,t} + \alpha_3 CFO_{j,t} + \alpha_4 Size_{j,t} + \alpha_5 Lev_{j,t} + \alpha_6 Tangile_{j,t} + \alpha_7 IPOage_{j,t} + \alpha_8 ARET_{j,t} + \alpha_9 ROE_{j,t} + \alpha_{10} IMR_{j,t} + Industry\ and\ Year\ Fixed\ Effects + \varepsilon_{j,t+1} \quad (3)$$

We then examine whether the association between government subsidies and investment efficiency varies with the subsidy recipients' financial constraints. Two measures of financial constraints are the SA (size_ age) index and Altman *Z*-score. Following Hadlock and Pierce (2010), we calculate the SA index for each firm-year observation as $-0.737 \times SIZE + 0.043 \times SIZE^2 - 0.04 \times AGE$, where AGE stands for firm age. The greater the SA score, the more severe the financial constraint. We directly retrieve the Altman Z-score from the WIND database. A higher Altman Z-score represents a lower level of financial constraint

Table 2
The effect of government subsidies on corporate investment efficiency (H1 and H2).

	(1) – H1 testing DV: Invest Eq. (1)	(2) – H2 testing DV: Over_Invest Eq. (3)	(3) – H2 testing DV: Under_Invest Eq. (3)
	Coeff. (*t*-stat)	Coeff. (*t*-stat)	Coeff. (*t*-stat)
Intercept	−0.042**	−0.027**	0.071***
	(−2.54)	(−2.36)	(10.40)
Subsidy	1.121***	0.294***	−0.237***
	(5.64)	(3.48)	(−4.92)
Q	0.002***	0.001**	−0.000*
	(3.08)	(2.17)	(−1.73)
Q_Subsidy	−0.183***	–	–
	(−2.83)	–	–
CFO	0.074***	0.049***	−0.009***
	(10.62)	(9.54)	(−3.31)
Size	0.004***	0.001***	−0.002***
	(5.24)	(2.83)	(−6.92)
Lev	−0.009**	−0.005*	0.003**
	(−2.31)	(−1.74)	(2.17)
Tangibl	0.040***	0.019***	−0.012***
	(7.62)	(5.07)	(−5.73)
IPOage	−0.002***	−0.001***	0.000***
	(−14.93)	(−11.43)	(6.97)
ARET	0.001	0.000	0.000
	(0.90)	(0.59)	(0.38)
ROE	0.043***	0.014***	−0.004
	(6.81)	(2.97)	(−1.51)
Year & Industry fixed effects	Controlled	Controlled	Controlled
Obs.	12,431	12,431	12,431
Adjusted R^2	0.223	0.198	0.193

Note: The t-statistics are reported in parenthesis. ***, **, and * represent statistical significance at the 1%, 5%, and 10% levels respectively (two-tailed test). Continuous variables are winsorized at their 1st and 99th percentiles. Variable definitions are in Table 1.

(Altman, 1968). We then use the median SA or Altman Z-score to partition the full sample into a less financially constrained sub-sample and a highly financially constrained sub-sample. Then, Eq. (1) is re-estimated for each sub-sample.

4. Empirical findings

4.1. Descriptive statistic and correlations

Table 1 shows the descriptive statistics and correlation matrix. Panel A of Table 1 reports that, on average, firms tend to invest about 5.5% of last year's total assets (*Invest*), and that subsides (*Subsidy*) account for 0.4% of the total assets. Firms' average leverage (*Lev*) is about 45.7% and the fixed assets account for 25.4% of total assets. The Pearson correlation matrix shown in Panel B of Table 1 shows that investment (*Invest*) is positively correlated with growth (*Q*), subsidies (*Subsidy*), cash flow from operations (*CFO*), firm size (*Size*) and profitability (*ROE*), but negatively correlated with leverage (*Lev*) and listing age (*IPOage*). These correlations are consistent with the existing literature.

4.2. Main results

The results of Eq. (1) are reported in Table 2. Column (1) of Table 2 reports positive and significant coefficients on *Subsidy* and *Q* for explaining investment (*Invest*) (coefficients on *Subsidy* and *Q* are 1.121 and 0.002, respectively; the *t* statistics are 5.64 and 3.08, respectively; both *p*-values < 1%). These results suggest that subsidies are positively related to firms' level of investment, and firms with high growth opportunities (*Q*) have more investments, which is consistent with our theory. The negative coefficient on *Q_Subsidy* suggests that subsidies mitigate the positive association between investment (*Invest*) and growth opportunity (*Q*) (coefficient is −0.183; *t* statistic is −2.83; *p*-value < 1%). That is, recipients of subsidies tend to reduce investment efficiency. The control variables show the expected signs, suggesting that firms tend to invest more when they have higher levels of cash flow (*CFO*), are large rather than small (*Size*), have more tangible assets (*Tangile*) and show a higher profitability (*ROE*). In contrast, corporate investment is lower when firms have more debt (*Lev*) and have been listed for a longer time (*IPOage*).

To investigate whether the decreasing effect of subsidies on investment efficiency is due to over- or under-investment, we estimate Eq. (2) to calculate *Over_Invest* and *Under_Invest* for each firm-year observation. Then we estimate Eq. (3) with *Over_Invest* and *Under_Invest* as the dependent variables. The results, reported in columns (2) and (3) of Table 2, show that subsidies have a positive effect on over-investment (*Over_Invest*) but a negative effect on under-investment (*Under_Invest*) (coefficients are 0.294 and − 0.237, respectively; *t* statistics are 3.48 and −4.92, respectively; both *p*-values < 1%). These findings suggest that government subsidies encourage over-investment but mitigate under-investment, supporting Hypothesis 2. In addition, some control variables have

Table 3
The differential effect of subsidies on investment efficiency at low vs. high levels of financial constraints (H3 testing).

DV: Invest	(1)	(2)	(3)	(4)
	Less financially constrained firms (SA < median) Eq. (1)	Highly financially constrained firms (SA > = median) Eq. (1)	Less financially constrained firms (Altman Z score > median) Eq. (1)	Highly financially constrained firms (Altman Z score = < median) Eq. (1)
	Coeff. (*t*-stat)	Coeff. (*t*-stat)	Coeff. (*t*-stat)	Coeff. (*t*-stat)
Intercept	−0.038	−0.057**	−0.045*	−0.081***
	(−1.58)	(−2.49)	(−1.78)	(−3.51)
Subsidy	1.145***	0.975***	1.464***	0.458
	(4.06)	(3.53)	(5.06)	(0.89)
Q	0.002**	0.003***	0.002***	0.008***
	(2.16)	(3.38)	(2.77)	(3.27)
Q_Subsidy	−0.213**	−0.111	−0.254***	0.113
	(−2.54)	(−1.12)	(−3.29)	(0.37)
CFO	0.088***	0.064***	0.057***	0.091***
	(8.62)	(7.15)	(5.93)	(9.56)
Size	0.004***	0.004***	0.004***	0.005***
	(3.91)	(4.07)	(3.73)	(5.35)
Lev	−0.009	−0.000	−0.007	−0.012**
	(−1.59)	(−0.06)	(−1.15)	(−2.02)
Tangibl	0.048***	0.036***	0.042***	0.037***
	(6.10)	(5.38)	(5.58)	(5.48)
IPOage	−0.003***	−0.001**	−0.002***	−0.002***
	(−11.98)	(−2.57)	(−11.91)	(−9.56)
ARET	0.002	−0.001	0.002	−0.002
	(1.57)	(−0.56)	(1.21)	(−1.57)
ROE	0.035***	0.041***	0.031***	0.049***
	(3.91)	(5.08)	(3.00)	(6.55)
Year & Industry fixed effects	Controlled	Controlled	Controlled	Controlled
Obs.	6216	6215	6216	6215
Adjusted R^2 (%)	0.212	0.239	0.207	0.256

Note: The t-statistics are reported in parenthesis. ***, **, and * represent statistical significance at the 1%, 5%, and 10% levels respectively (two-tailed test). Continuous variables are winsorized at their 1st and 99th percentiles. Variable definitions are in Table 1.

opposite relationships with over-investment (*Over_Invest*) and under-investment (*Under_Invest*). For instance, cash flow (*CFO*) is positively related to *Over_Invest* but negatively related to *Under_Invest*. Large firms (*Size*) are more likely to over-invest, as shown by a positive relationship with *Over_Invest*, but are less likely to under-invest, as shown by the negative coefficient on *Under_Invest*.

We then analyse the moderating effect proposed in Hypothesis 3. To this end, we estimate Eq. (1) for the two sub-samples of firm-years with strong (weak) financial constraints. The results are reported in Table 3. We find that government subsidies reduce the investment efficiency of less financially constrained firms, but do not reduce the investment efficiency of firms with strong financial constraints. Columns (1)–(2) report the results using the median SA score as the criteria, where a high SA score suggests a high level of financial constraints. The results using the median Altman *Z*-score as the criteria are reported in columns (3)–(4), where a low Altman Z-score indicates a high level of financial constraints.

The results in Table 3 show that *Subsidy* mitigates investment efficiency in the sub-sample of firms with lower levels of financial constraints, as shown in columns (1) and (3) (coefficients are −0.213 and −0.254, *t* statistics are −2.54 and −3.29; both *p*-values < 1%). However, subsidies do not reduce investment efficiency in firms with high levels of financial constraints, as shown by the insignificant coefficients on *Q_Subsidy* for both models reported in columns (2) and (4). These findings indicate that subsidies are not used efficiently by firms that have relatively easy access to financing, whereas firms facing stronger financial constraints are unlikely to waste the subsidies. The negative effects of subsidies on corporate investment efficiency are probably due to a two-step process: when financial resources are abundant, the subsidies contribute to over-investment and thus waste. This highlights the importance of government scrutiny in subsidy-granting decisions and the necessity of monitoring the efficacy of subsidies at the firm level.

4.3. Robustness tests

We now consider some robustness tests to alleviate concerns about potential endogeneity between subsidies and corporate investment efficiency. Moreover, we cannot rule out the possibility that firms with the innate tendency to over-invest actively seek subsidies (problem of self-selection) or the possibility that certain inherent firm characteristics are correlated with both investment efficiency and the pursuit of subsidies (omitted variables). If this were the case, our results would be spurious. To alleviate concerns regarding the self-selection bias and omitted variable problems, we conduct a batch of tests including a two-stage least squares (2SlS) regression analysis, propensity score matching (PSM) methods and Heckman two-stage regressions. Our results are robust to these

Table 4
Two-stage least squares (2SLS) test to alleviate concern for Endogeneity.

Panel A: The results of H1 and H2 testing.

	(1) – H1 testing DV: Invest Eq. (1)	(2) – H2 testing DV: Over_Invest Eq. (3)	(3) – H2 testing DV: Under_Invest Eq. (3)
	Coeff. (*t*-stat)	Coeff. (*t*-stat)	Coeff. (*t*-stat)
Intercept	−0.077***	−0.036***	0.060***
	(−5.67)	(−4.31)	(10.94)
Subsidy	2.423***	0.530***	−0.455***
	(5.65)	(3.15)	(−4.70)
Q	0.003***	0.002**	−0.001**
	(3.00)	(2.35)	(−2.13)
Q_Subsidy	−0.469***	–	–
	(−3.15)	–	–
All Variables in Main Test	Controlled	Controlled	Controlled
Year & Industry fixed effects	Controlled	Controlled	Controlled
Obs.	9133	9133	9133
Adjusted R^2	0.226	0.108	0.202

Panel B: The results of H3 testing.

DV: Invest	(1)	(2)	(3)	(4)
	Less financially constrained firms (SA < median) Eq. (1)	Highly financially constrained firms (SA > = median) Eq. (1)	Less financially constrained firms (Altman Z score > median) Eq. (1)	Highly financially constrained firms (Altman Z score = < median) Eq. (1)
	Coeff. (*t*-stat)	Coeff. (*t*-stat)	Coeff. (*t*-stat)	Coeff. (*t*-stat)
Intercept	−0.074***	−0.092***	−0.084***	−0.118***
	(−4.08)	(−4.09)	(−3.89)	(−5.70)
Subsidy	2.196***	2.482***	2.745***	2.011**
	(4.10)	(3.41)	(3.92)	(2.16)
Q	0.004***	0.002	0.003***	0.010***
	(2.87)	(1.34)	(2.63)	(3.59)
Q_Subsidy	−0.394**	−0.431*	−0.532***	−0.347
	(−1.99)	(−1.87)	(−2.67)	(−0.64)
All Variables in Main Test	Controlled	Controlled	Controlled	Controlled
Year & Industry fixed effects	Controlled	Controlled	Controlled	Controlled
Obs.	4997	4136	4528	4605
Adjusted R^2 (%)	0.248	0.234	0.272	0.272

Note: The t-statistics are reported in parenthesis. ***, **, and * represent statistical significance at the 1%, 5%, and 10% levels respectively (two-tailed test). Continuous variables are winsorized at their 1st and 99th percentiles. Variable definitions are in Table 1.

tests, which produce findings that are largely consistent with our main results.

First, in our 2SLS regression, the first-stage regression is conducted with two instrument variables in the form of the industry mean subsidy in each year and the lagged firm-level subsidy. The results of second-stage regressions that use Eqs. (1) and (3) to test Hypotheses 1–3 are reported in Table 4. Panel A of Table 4 shows the results of testing Hypotheses 1 and 2. Column (1) reports a consistent negative coefficient on *Q_Subsidy*, suggesting that subsidies mitigate the positive association between investment and growth opportunity (*Q*). Columns (2) and (3) show that subsidies are positively related to over-investment but negatively associated with under-investment. Panel B of Table 4 shows the differential effect of subsidies on investment efficiency for firms with high (low) levels of financial constraints. These findings are consistent with our main results, supporting the finding that the negative effect of subsidies on investment efficiency is more severe for firms that are less financially constrained.

We also conduct Heckman's (1979) two-stage test procedure. The first stage involves the estimation of a probit model where the dependent variable, defined by whether the firm receives a subsidy, is regressed on a set of firm-specific control variables. These variables include political connection (*PCON*),[6] number of employees (*STAFF*),[7] operating cash flow (*CFO*), firm size (*Size*), leverage

[6] Political connections are measured as a dummy variable, taking a value of 1 if the chairman or CEO has political ties, and 0 otherwise. Political ties exist if (1) the chairman or CEO is a member of the National People's Congress (NPC), (2) the chairman or CEO is a member of the National Committee of the Chinese People's Political Consultative Conference (CPPCC) or (3) either served as a government official in provincial, municipal or county-level governments before they became the chairman or CEO in the listed firm.

[7] *STAFF* is a proxy for government rent seeking in which the government forces connected firms to provide more job opportunities. It is measured as the natural log of the number of employees. The rest of the variables are the same as those used in Eq. (1).

Table 5
Heckman tests to alleviate concern for self-selection.

Panel A: The results of H1 and H2 testing.

	(1) DV: Invest	(2) DV: Over_Invest	(3) DV: Under_Invest
	Coeff. (t-stat)	Coeff. (t-stat)	Coeff. (t-stat)
Intercept	0.062***	0.035**	0.011
	(2.60)	(2.10)	(1.22)
Subsidy	0.977***	0.343***	−0.195***
	(5.20)	(4.56)	(−5.14)
Q	0.002***	0.002**	−0.001**
	(3.22)	(2.11)	(−1.73)
Q_Subsidy	−0.147**	–	–
	(−2.25)	–	–
IMR	−0.044***	−0.009*	0.017***
	(−5.20)	(−1.65)	(5.08)
All Variables in Main Test	Controlled	Controlled	Controlled
Year & Industry fixed effects	Controlled	Controlled	Controlled
Obs.	12,431	12,431	12,431
Adjusted R^2 (%)	0.205	0.070	0.196

Panel B: The results of H3 testing.

DV: Invest	(1) Less financially constrained firms (SA < median)	(2) Highly financially constrained firms (SA > = median)	(3) Less financially constrained firms (Altman Z score > median)	(4) Highly financially constrained firms (Altman Z score = < median)
	Coeff. (*t*-stat)	Coeff. (*t*-stat)	Coeff. (*t*-stat)	Coeff. (*t*-stat)
Intercept	0.056*	0.036	0.043	0.044
	(1.65)	(1.08)	(1.30)	(1.42)
Subsidy	0.931***	0.987***	1.391***	0.583*
	(3.30)	(3.87)	(5.07)	(1.73)
Q	0.002**	0.003***	0.002***	0.006***
	(2.43)	(3.21)	(3.06)	(4.06)
Q_Subsidy	−0.196**	−0.075	−0.256***	0.017
	(−2.16)	(−0.75)	(−3.28)	(0.09)
IMR	−0.038***	−0.045***	−0.044***	−0.052***
	(−3.17)	(−3.99)	(−3.73)	(−4.52)
All Variables in Main Test	Controlled	Controlled	Controlled	Controlled
Year & Industry fixed effects	Controlled	Controlled	Controlled	Controlled
Obs.	6215	6216	6215	6216
Adjusted R^2 (%)	0.182	0.206	0.189	0.227

Note: The t-statistics are reported in parenthesis. ***, **, and * represent statistical significance at the 1%, 5%, and 10% levels respectively (two-tailed test). Continuous variables are winsorized at their 1st and 99th percentiles. Variable definitions are in Table 1.

(*Lev*), capita structure (*Tangibl*), the log of the number of years the firm has been listed (*IPOage*), excess returns (*ARET*) and profitability (*ROE*). The Heckman second stage regression results based on Eq. (1) are reported in column (1) of Table 5 Panel A. Here, one can see a negative estimated coefficient on *Q_Subsidy*. As reported in columns (2) and (3) of Table 5 Panel A, the Heckman second stage regressions using Eq. (3) with *Over_Invest* and *Under_Invest* as dependent variables show that subsidies have a positive effect on over-investment but a negative effect on under-investment (*Under_Invest*). Panel B of Table 5 reports the results for the conditional effect of subsidies on investment efficiency on financial constraints. The findings are in accordance with our main results.

Finally, we use PSM to address potential self-selection problems. The results are reported in Table 6. Using the PSM methodology of Rosenbaum and Rubin (1983, 1985), we match a group of firms who received subsidies (treatment group) with a group of firms that did not receive subsidies (control group) based on their similar firm-level characteristics according to a function of covariates. The results are based on matching done with a small calliper of 0.01 conducted without replacement.[8] After conditioning on the propensity score, we find no systematic differences in firm-level characteristics post-matching between treated and control subjects, as reported in Panel A of Table 6. This indicates that the propensity score model has been correctly specified (Austin, 2011). The test results using PSM matched samples are presented in Table 6 Panels B and C. Panel B column (1) shows a marginally negative coefficient on *Q_Subsidy,* and columns (2) and (3) show a significantly positive (negative) coefficient on *Subsidy* when *Over_Invest*

[8] We also try average treatment effect and nearest neighbour methods with various callipers, and the results are generally similar.

Table 6
Tests using Propensity Score Matching (PSM) technique to alleviate concern for self-selection.

Panel A: Variable covariate matching pre and post-PSM.

Variables	Sample with subsidy > 0				Sample with subsidy = 0					
	N	mean	median	sd	N	mean	median	sd	DIFF	tstats
Q	1231	2.441	1.949	1.492	1231	2.446	1.869	1.625	−0.005	−0.08
CFO	1231	0.050	0.048	0.076	1231	0.051	0.050	0.086	−0.001	0.32
SIZE	1231	21.502	21.438	1.024	1231	21.478	21.343	1.234	0.024	0.55
LEV	1231	0.478	0.488	0.174	1231	0.477	0.495	0.196	0.001	0.15
TANGIBL	1231	0.261	0.236	0.155	1231	0.268	0.235	0.202	−0.007	−1.02
IPOAGE	1231	11.200	11.342	4.751	1231	11.088	11.041	4.798	0.112	0.61
ARET	1231	0.025	−0.020	0.497	1231	0.023	−0.025	0.491	0.002	0.11
ROE	1231	0.071	0.067	0.095	1231	0.072	0.067	0.096	−0.001	−0.15

Panel B: The results of H1 and H2 testing using PSM matched samples.

	(1) DV: Invest	(2) DV: Over_Invest	(3) DV: Under_Invest
	Coeff. (t-stat)	Coeff. (t-stat)	Coeff. (t-stat)
Intercept	−0.058*	−0.017	0.086***
	(−1.87)	(−0.82)	(6.45)
Subsidy	0.985**	0.512**	−0.228*
	(1.97)	(2.34)	(−1.89)
Q	0.003**	0.002**	−0.001**
	(2.32)	(2.07)	(−2.27)
Q_Subsidy	−0.011*	–	–
	(−1.96)	–	–
All Variables in Main Test	Controlled	Controlled	Controlled
Year & Industry fixed effects	Controlled	Controlled	Controlled
Obs.	2462	2462	2462
Adjusted R^2 (%)	0.249	0.093	0.289

Panel C: The results of H3 testing using PSM matched samples.

DV: Invest	(1) Less financially constrained firms (SA < median)	(2) Highly financially constrained firms (SA > = median)	(3) Less financially constrained firms (Altman Z score > median)	(4) Highly financially constrained firms (Altman Z score = < median)
	Coeff. (*t*-stat)	Coeff. (*t*-stat)	Coeff. (*t*-stat)	Coeff. (*t*-stat)
Intercept	−0.054	−0.089*	−0.012	−0.162***
	(−1.13)	(−1.75)	(−0.24)	(−3.38)
Subsidy	1.594**	0.118	1.325*	0.645
	(2.40)	(0.14)	(1.73)	(0.47)
Q	0.004**	0.002	0.001	0.013***
	(2.27)	(1.39)	(0.92)	(2.87)
Q_Subsidy	−0.261	0.026	−0.302**	0.105
	(−1.46)	(0.11)	(−2.05)	(0.13)
All Variables in Main Test	Controlled	Controlled	Controlled	Controlled
Year & Industry fixed effects	Controlled	Controlled	Controlled	Controlled
Obs.	1481	981	1137	1325
Adjusted R^2 (%)	0.243	0.260	0.218	0.290

Note: The t-statistics are reported in parenthesis. ***, **, and * represent statistical significance at the 1%, 5%, and 10% levels respectively (two-tailed test). Continuous variables are winsorized at their 1st and 99th percentiles. Variable definitions are in Table 1.

(*Under_Invest*) are the dependent variables. In addition, Panel C reports that subsidies' negative effect on investment efficiency is more pronounced in firms whose financial resources are less constrained when the Altman *Z*-score is used to measure the financial resource constraints, as reported in columns (3) and (4). However, the coefficients on *Q_Subsidy* are insignificant for this analysis when SA is used to measure the financial constraints, as reported in columns (1) and (2).

5. Conclusion

Corporate investment efficiency is essential to corporate profitability and ultimately contributes to industry- and country-level

economic development. We find that government subsidies have an adverse effect on corporate investment efficiency. Our investigation further shows that this effect is driven by over-investment by firms that receive subsidies. However, subsidies do appear to address under-investment problems in some recipients. Additionally, our analyses demonstrate that government subsidies reduce the investment efficiency of less financially constrained firms, but do not reduce the investment efficiency of firms with greater levels of financial constraints. This suggests that subsidies should be used with care, as they can result in improved investment efficiency when the recipients have scarce financial resources, but may induce waste in firms that have easy access to financial resources. In general, our findings point to the need for a careful choice of subsidy recipients. Government authorities granting subsidies need to more closely monitor the utility of the subsidies to ensure investment efficiency and avoid wasteful resource allocation. Our findings have implications for other countries where governments use subsidies as a means of economic management.

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